Center of Excellence in Broadband Mobile Wireless Communications & Networking

Dr. Honggang ZHANG, Professor
College of Information Science & Engineering
Zhejiang University
Hangzhou, China
June, 2008
Outline

1. Introduction
2. Objectives & Priority Themes
3. Research Directions
4. Research Results & Achievement
5. Events & Dissemination
1. Introduction

Key-Players @ COE-BMW (Zhejiang University)

Prof. Honggang ZHANG

A/Prof. Huifang CHEN

A/Prof. Zhifeng ZHAO

A/Prof. Guanding YU
2. Objectives & Priority Themes

Window of Opportunity

- Existing spectrum policy forces spectrum to behave like a fragmented disk
- Bandwidth is expensive and good frequencies are taken
- Unlicensed bands – biggest innovations in spectrum efficiency
- Recent measurements by the FCC in the US show 70% of the allocated spectrum is not utilized
- Time scale of the spectrum occupancy varies from ms to hours
Dynamic Spectrum Access & Management Opportunities

Existing services
- Long Wave Radio
- Medium Wave Radio
- Short Wave International broadcasting
- FM Radio

Emerging services
- DRM Digital Radio
- Mobile TV
- Local TV
- HDTV
- WiMax
- PMSE
- WiFi
- Microwave radio links
- Satellite links
- Freesat Digital TV
- DAB Digital Radio
- 3G and 2G mobile phones

"Sweetspot"

Power
Frequency
Spectrum in Use

"Spectrum Hole"

Dynamic Spectrum Access

Time

Courtesy of Dr. Stefan Mangold
The Key Roles of Cognitive Radio (CR)
Cognitive Radio & Networks - Perspective

- Cognitive Radio & Networking recently has been hailed to be the "Next Big Thing" in future wireless communications.
- The uniqueness of Cognitive Radio & Networking is its ability to make efficient use of resource-limited spectrum, based on autonomously interacting with and adapting to wireless channels and/or networking environment.
- Cognitive Radio & Networking is suitable for radio nodes cooperation to share spectrum and can be applied to realizing autonomous, spectrum-agile radios with intelligent wireless networking.

→ To exploit various features, potentials and advances of Cognitive Radio & Networking (CRN)
Promises of Cognitive Radio & Networking

- Cognitive Radio & Networking can detect its operating wireless environment and learn how to adapt and evolve.
- Cognitive Radio & Networking can adjust itself to handle anticipated and unanticipated wireless channels and environments.
- Cognitive Radio & Networking requires:
  - Sensing
  - Learning & Action
  - Adaptation & Evolution

- Cognitive Radio & Networking can achieve an expected quality of service (smart transmitting/relaying node) as well as mitigate interference to neighboring radios (smart receiving/cooperative node).
Ready for the Wireless Storms?

**Cognitive Radio & Networking:**

- Is it a coming revolution & storm in wireless world?
  - Dynamic, open access to spectrum resource (Open Spectrum)
  - Adaptive spectrum sensing, opportunistic spectrum allocation and acquisition (Spectrum-agility)
  - Infrastructure-free mesh networks (CogMesh)
  - Intelligent radio, autonomic communications and Bio-inspired radio/networks (BioNets)

- Do we have any key application?
  - Dual-, triple-mode mobile phone, Smart Radio (post-iPhone)
  - WiFi, WiMAX, and B3G/4G coexistence and convergence for heterogeneous networks
  - Cognitive mesh networks (Mobile digital TV broadcasting)
  - Cognitive Ultra-wideband Radio (WPAN/WBAN, end-to-end reconfigurability, eHealth, eSoldier, eSports)
  - Bio-communications and bio-networks

- How about industry, standardization and regulation procedure?
  - Recent FCC rulemaking (December 2003, April 2004, March 2005)
  - IEEE 802.22 Cognitive Wireless Regional Area Network (WRAN)
  - IEEE 802.16h
  - IEEE P1900 (SCC 41)
3. Research Directions: Topics & Focuses

- To investigate and develop various efficient & advanced Signal Processing methods aimed at sensing the surrounding heterogeneous wireless environments consisted of various primary users and secondary spectral users, thus allowing the cognitive radio device to generate a real-time interactive mapping of the radio scene (e.g. available spectrum resources), estimate multi-dimensional channel, determine neighborhood interference patterns, and present relevant information to higher protocol layers.

- To address spectrum-agile, location-aware, context-aware, user-aware and service-aware Signal Processing approaches after sensing, detecting and differentiating the wireless environments. In this respect, it is necessary to explore how to realize a variety of spectrum-agile approaches (dynamic spectrum access & sharing) at physical (PHY), Medium Access Control (MAC) and network layers.

- To introduce novel Signal Adaptation schemes to cope with interference and coexistence issues, both in centralized and cooperatively distributed control mode, in multiple domains including time, frequency and space.
Research Topics & Focuses (con’t)

- To investigate the fundamental networking issues in a cognitive networking context, such as development of learning and decision-making functionalities for different kinds of networking protocols for a varying number of cognitive radio nodes. The aim is to enable various cognitive radio nodes in taking intelligent decisions, by exploring artificial intelligence (AI) strategies for negotiation, cooperation, and conflict-solving among these cognitive radio nodes with different functionalities, capabilities, and capacities.

- To verify the technological feasibility of cognitive radio networking especially the wireless channel sensing, interference detection, and adaptive coexistence by the development and demonstration of dedicated test-bed solutions.

- To devote a significant amount of efforts to standardization involvements making relevant contributions to the corresponding spectrum regulation & policy reforms around the world, including various standardization bodies like IEEE 802, and IEEE P1900 (SCC 41), ETSI, and ITU-R.
4. CR-related Results & Achievement

Book & Book Chapter Publications


Journal Publications

CR-related Results & Achievement (con’t)

Conference Publications

5. Events & Dissemination

2. IEEE Globecom 2008 General Symposium on Selected Areas in Communications (GA-SAC) - Cognitive Radio & Networks Tracks
5. IEEE CoCoNets 2008
Thank You!

Dr. Honggang ZHANG, Professor
Department of Information Science & Electronic Engineering
Zhejiang University
Email: honggangzhang@zju.edu.cn